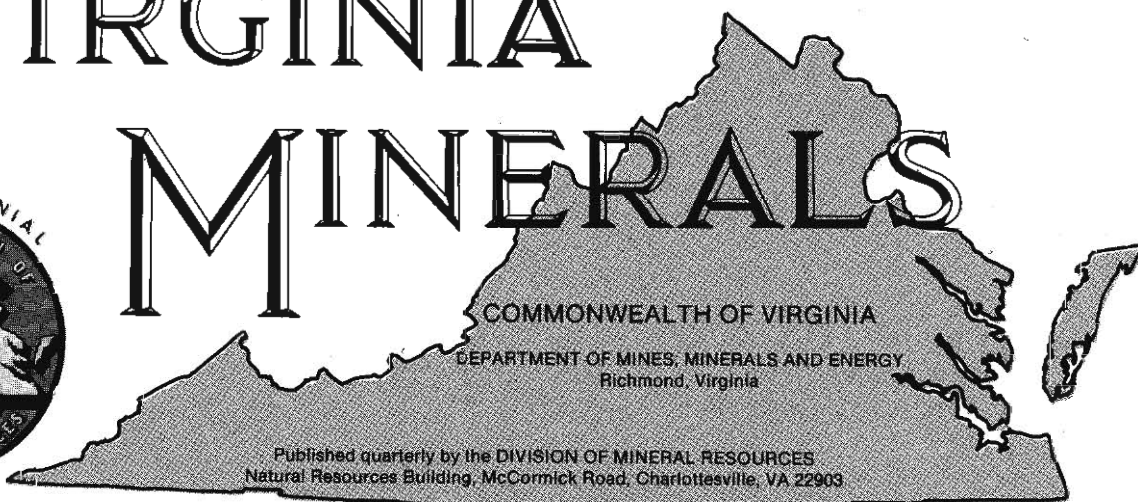
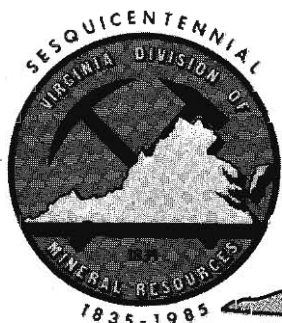


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## MINERALOGY AND CHEMISTRY OF GOLD IN THE VIRGILINA DISTRICT, HALIFAX COUNTY, VIRGINIA

Michael A. Linden<sup>1</sup>,  
James R. Craig<sup>2</sup>, and Todd N. Solberg<sup>2</sup>

### INTRODUCTION

The Virgilina district of Halifax County in south central Virginia is a minor but well-documented gold region of the central Appalachians. The district (Figure 1), which extends from Virginia into North Carolina with a total length of about 60 miles, was best known for its copper mines. From the mid-1800's until 1917 the mines in the Virginia portion of the district produced approximately 750,000 pounds of refined copper (Sweet, 1976) as well as significant by-product silver and minor amounts of gold. Gold was recovered primarily from the Red Bank mine and the Luce-Howard mine although numerous trenches, pits, and evidences of placer workings are present throughout the area. The district was selected for study because of its accessibility and limited size and because it appears to be representative of many gold occurrences in Virginia and throughout the Piedmont.

### HISTORY OF GOLD MINING IN THE DISTRICT

The Virgilina district is best known for its production of copper ores which have been described by Watson (1907), Laney (1917), Sweet (1976), and Sweet and Trimble (1983); much less is known of the gold recovery efforts.

Although placer gold was no doubt found in the streams of the Virgilina district in the early to mid-1800's, active gold mining only began in about 1903 after the discovery of gold-bearing quartz veins at the site of the Red Bank mine by Mr. H. C. Crowley. The Virgilina Gold Mining Company purchased the property in 1905 and subsequently sank two vertical shafts, 50 and 200 feet deep, and developed 650 feet of drifts (Laney, 1917). Stoping was considerable down to the 70-foot level, but all work apparently was confined to a single vein. Two batteries of five stamps each (Figure 2) were used

<sup>1</sup>U. S. Forest Service, Roanoke, VA 24001

<sup>2</sup>Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

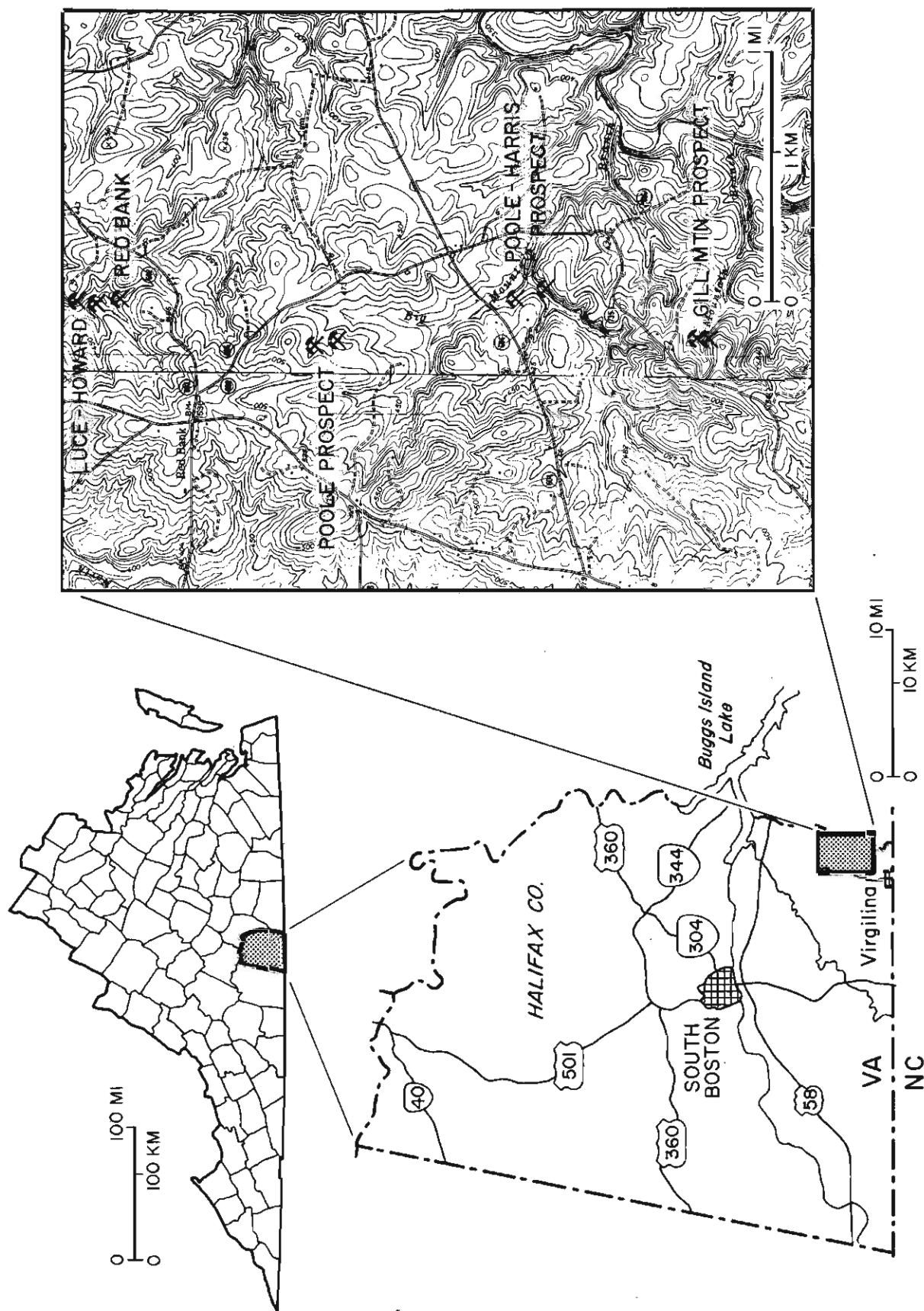


Figure 1. Gold occurrences in Halifax County. The detailed area represents parts of both the Virgilina and Nelson 1:24,000 quadrangles.

to crush the vein material into a fine powder which was then passed in a stream of running water over mercury-coated copper amalgamating plates. Large gold grains adhered to the mercury and were recovered; unfortunately, much of the very small-sized gold floated across the plates and was lost into the tailings pond. Cyanide leaching equipment was purchased to enhance gold recovery but was apparently never put into operation. Some shafts and drifts were driven at the Luce-Howard property, but activity there ceased prior to 1912 (Laney, 1917).

Accurate assay and production data are limited, but Watson (1907) reported that during 1906, a 6-foot-wide vein at the Red mine produced 10 tons of ore a day which were milled at an average value of \$8.00 per ton. Based on the then current price of gold of \$20.67 per troy ounce, the vein averaged at least 0.39 troy oz/ton. The ore was said to occur in "ore shoots" within the vein, and gold values were reportedly irregular in distribution. Through 1912 total gold production for the district equalled approximately \$22,000 (a little over 1000 troy ounces). From 1937 to 1942 the Red Bank mine again produced minor amounts of gold, apparently from the extension of older workings (Sweet, 1971). Laney (1917) notes that the southern part of the gold-bearing portion of the Virgilina district contains many irregular quartz veins and is known locally as Gill's Mountain. During the course of the study, the investigators were made aware of the presence of small amounts of gold at a previously-unreported site near Gill's Mountain. The gold of this site appears similar in setting and chemistry to that of the Poole-Harris prospects.

#### REGIONAL GEOLOGY AND NATURE OF THE VEINS

The Virgilina district lies within the Precambrian- to Cambrian-aged volcanic and sedimentary rocks, metamorphosed to greenschist facies, of the Aaron Formation in the Virgilina synclinorium (Laney, 1917; Glover and Sinha, 1973; Conley, 1978). The trends of gold-bearing quartz veins apparently are sub-parallel to the regional strike (north-northeast), the veins dip 60 to 90 degrees to the southeast and are contained primarily within the middle greenstone member of the Aaron Formation. This greenstone member is a light-green actinolite-chlorite-epidote schist in the vicinity of the gold quartz veins and represents altered andesitic-basaltic flows and tuffs. The Virgilina quadrangle, immediately to the west of the Nelson

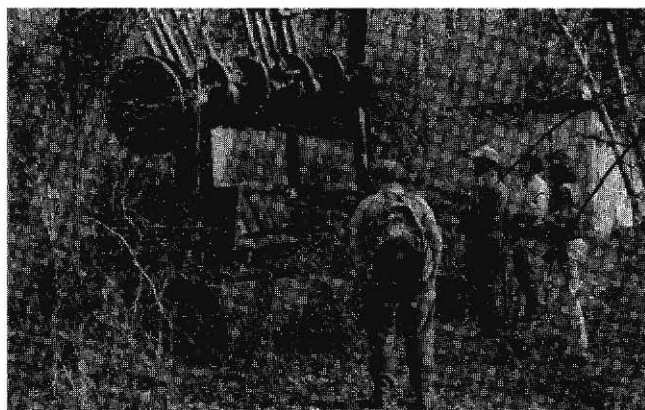


Figure 2. Two batteries of stamps formerly used to crush gold-bearing rocks at the Red Bank mine.

quadrangle containing the once active gold mines, was mapped by Kreisa (1980), but the detailed geology of the area containing the gold-quartz veins remains to be deciphered. Glover (personal communication, 1981) has pointed out the possible close relationship of the veins to major faults and granitic intrusions in the area.

Although quartz veins are present throughout the Virgilina district, Laney (1917) reports that only those veins within the greenstone units are significantly mineralized. The veins, which appear to represent fissure fillings, and host rock replacement, are irregular in their geometry and range from an inch to more than 9 feet in thickness. The veins commonly have sharp contacts, but locally incorporate portions of the host rocks. The quartz is generally milky white because of an abundance of tiny fluid inclusions. In some areas, however, a second generation of vitreous clear quartz with crystal faces is also present. The age of the gold, relative to that of the two generations of quartz, is not known, but one specimen (supplied by P. Sweet of the Virginia Division of Mineral Resources and collected by Laney) contained gold with hematite and copper-iron sulfides (Figure 3) and appeared to correspond to the first generation of milky quartz.

Siderite and ankerite are present locally admixed with the quartz; they are readily recognized by their brownish weathered surface. Specular hematite is abundant locally and sometimes occurs as broken laths up to several centimeters in length. Epidote, chlorite, plagioclase feldspar, limonite, and a few lenses of jasper also are present. Minor amounts of chalcopyrite, pyrite, galena, magnetite, bornite, chalcocite, and covellite were observed.

The presence of the copper minerals with the gold suggests a possible genetic relationship between the gold-bearing veins and the copper-rich veins. This relationship further is strengthened by Laney's (1917) comment that the copper-rich veins of the district are very slightly gold bearing and Johnson's (1983) discovery of gold in copper-bearing veins of the Daniel's mine in eastern Charlotte County at the northern end of the district.

### RECOVERY OF GOLD

Gold from the Virgilina district was recovered for this study from: (1) stream sediments (placer materials) by conventional panning techniques; (2) samples collected by Laney when he visited the area in the early 1900's; (3) dump materials adjacent to mine sites (lode samples); and (4) the stamp and adjacent waste pond at the Red Bank mine. Stream sediments and waste-pond materials were wet sieved through a 40-mesh grid and hand panned to a heavy concentrate from which gold grains were picked. Dump material was pulverized in a jaw crusher and roller mill until approximately one-half passed through a 40-mesh grid; the entire sample was then hand panned. Only the sample collected by Laney had sufficient gold to be seen and analyzed without use of a concentration technique. The placer gold particles (Figure 4) were generally rounded to flattened, with their longest dimension less than 1 mm. Gold grains recovered from vein materials were characteristically jagged and commonly displayed planar faces because of growth adjacent to quartz crystal faces. The mean particle size for gold recovered was 0.29 mm, and more than 70 percent of all gold recovered was less than 0.35 mm; the largest grain observed was 1.13 mm across.

### ANALYSIS AND COMPOSITION OF THE GOLD

Analysis of the gold was carried out under the direction of T. N. Solberg by means of the electron microprobe in the Department of Geological Sciences at Virginia Polytechnic Institute and State University. This analysis permits non-destructive determination of the chemistry by measurement of the characteristic x-rays emitted by each element present when an electron beam impinges on the sample at 15-20 kv. All gold particles were mounted in a cold-setting epoxy and then ground and polished. In order to remove surface contamination (because of the malleable nature of the gold), gold

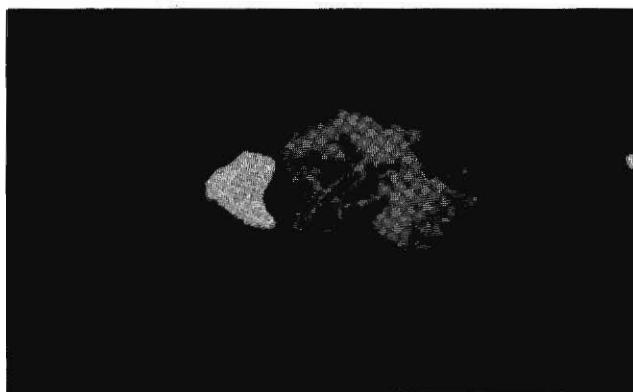


Figure 3. Gold (white phase) with intergrown chalcopyrite and bornite and marginal chalcocite (field of view = 0.12 mm). This sample was collected from the Red Bank Mine by F. B. Laney before 1917 and was supplied courtesy of the Virginia Division of Mineral Resources.

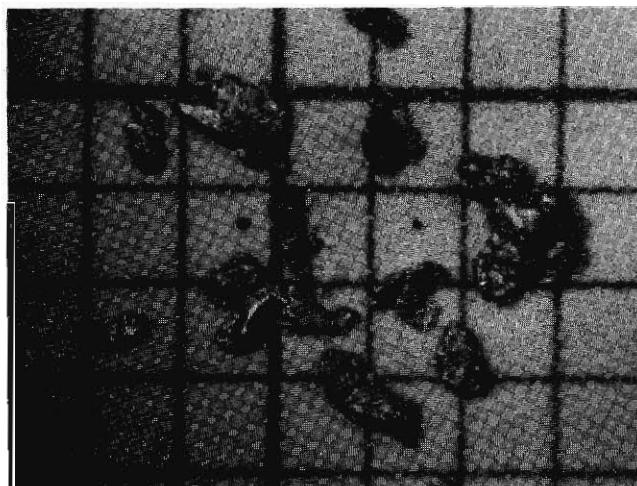


Figure 4. Typical placer gold grains from the Virgilina district. Grains are on a millimeter grid.

grains were lightly etched with a 1.5 percent potassium cyanide-ammonium persulfate solution. Analysis was carried out for gold, silver, copper, mercury, nickel, iron, cobalt, lead, palladium, zinc, antimony, and arsenic.

The "gold" of the Virgilina district, like that of most other areas, consists primarily of gold and silver with minor amounts of copper and only trace quantities of other metals (Antweiller and Campbell, 1977; Craig et al., 1981). As shown in Figure 5, the gold of the Virgilina district has been found to range in fineness (fineness =  $[(\text{Au}/(\text{Au} + \text{Ag})) \times 1000; \text{wt } \%]$ ) from 612 to 985 with that from the

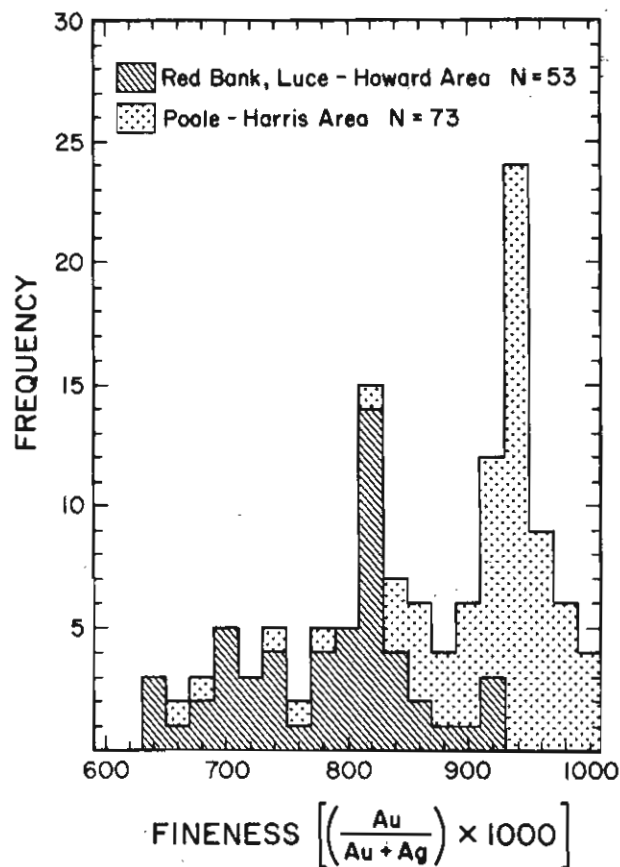


Figure 5. Histogram indicating the compositions of gold particles from the Red Bank, Luce-Howard, and Poole-Harris areas of Halifax County. Note the distinctly different, but slightly overlapping, populations.

northern portion of the area (Red Bank, Luce-Howard) having a significantly lower fineness (mean near 800) than that from the southern portion (Poole-Harris; mean near 920). This also correlates with gold particle size; the range from the Red Bank area is 0.005 to 0.54 mm; whereas, that from the Poole-Harris area is 0.005 to 1.13 mm. Thus, gold recovered from the Red Bank, Luce-Howard area, which displays lower fineness, tends to be smaller in particle size than gold recovered from the Poole-Harris area.

The plot in Figure 6 illustrates the range in fineness versus copper content for the two portions of the Virgilina district. It is apparent that the concentration of copper generally increases with an increase in fineness; hence, the high copper values are found in the Poole-Harris region in the southern part of the district. Copper contents of gold from the Poole-Harris prospect region ranged

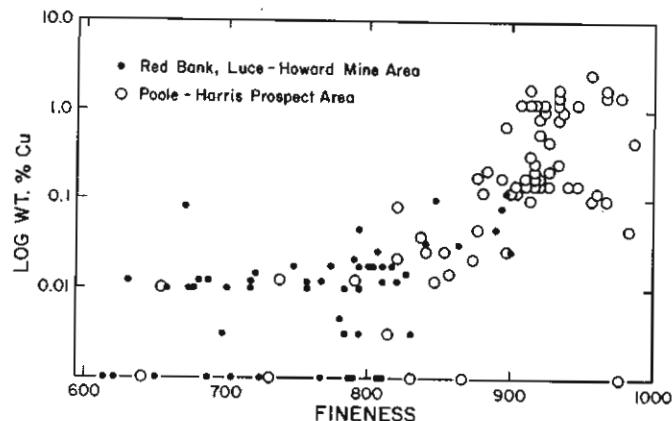


Figure 6. Fineness versus log wt. percent copper in gold grains from the Virgilina district.

from below the detection limit (less than 0.01 wt. percent) to 4.63 wt. percent. In contrast, gold analyzed from the Red Bank and Luce-Howard area had a copper content which ranged from below the detection limit to a maximum of only 0.15 wt. percent. The greater concentrations of copper found in samples of higher fineness gold (or gold with lower silver contents) are consistent with phase equilibrium studies involving gold, silver, and copper (Sistare and McDonald, 1979). These studies indicate that copper is more easily incorporated into the crystal structure of higher fineness gold.

Other than silver and copper, mercury is the only other metal which has been found in significant concentrations in the gold of the Virgilina district. Mercury is present in concentrations of up to about 0.1 wt. percent in the interiors of many placer and lode gold particles and in concentrations of up to 10 wt. percent on the surfaces of some placer particles. The low concentrations in the interiors of particles may well be natural inasmuch as the distribution within each grain is uniform and inasmuch as mercury is a common minor to trace element in many types of gold deposits (Warren and Thompson, 1944; Boyle, 1979). The very irregular and local occurrence of much higher concentrations of mercury on the surface of gold particles is no doubt the result of contamination from mercury lost during past amalgamation or panning efforts. Numerous old records note the use of mercury as an amalgamation agent, and mercury amalgam coatings on grains have been reported elsewhere in the Appalachians (Solberg and Craig, 1981).



## SUMMARY AND ACKNOWLEDGEMENTS

The setting of gold ores of the Virginia portion of the Virgilina district has been investigated and the mineralogy and chemistry characterized. Gold occurs as discrete particles and in association with hematite and minor sulfides in quartz veins which subparallel the attitude of the regional lithologies. The gold illustrates two compositional populations which correspond to different occurrences in the district. The experience and data gained provide a step in the development of a data base on Appalachian gold deposits which it is hoped will permit an understanding of the petrology and distribution of gold-bearing rocks.

The present contribution is an outgrowth of an M. S. thesis study at VPI & SU by Linden (1981) and a portion of a larger study of gold in the Appalachians being carried out by J. R. Craig and T. N. Solberg. The work was supported by the Virginia Division of Mineral Resources, a Minerals and Mining Resources and Research Institute allotment grant, and National Science Foundation Grant No. EAR-8011418. We are indebted to Palmer Sweet and T. Edison Buchanan for their assistance in the field.

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## THE PINEY POINT FORMATION ALONG THE PAMUNKEY RIVER, VIRGINIA COASTAL PLAIN

Linda T. Deck

The Pamunkey River has long been recognized for the excellent outcrops of Eocene sediments along its banks. These sediments were named the Pamunkey Formation by Darton in 1891. Clark (1896) divided the Pamunkey Formation into the Aquia Creek and Woodstock stages and later with Martin (1901) raised the formation to group status with two formations, the Aquia and the Nanjemoy. In 1912 Clark and Miller described several additional localities along the Pamunkey River that included beds younger than the type Nanjemoy. These younger beds, lithologically and paleontologically distinct from the Nanjemoy, were studied by Ward (1984), who correlated them with the Piney Point Formation of Maryland (Otton, 1955). This is the only documented surface occurrence of

the Piney Point in Virginia.

Along the Pamunkey River exposures of the Piney Point consist of a basal clayey, glauconitic sand 8 feet thick overlain by a layer of concretions. Overlying the concretions is a 15-foot-thick clayey, glauconitic sand, an indurated oyster bed, and a soft, non-fossiliferous, burrowed, medium- to coarse-grained glauconitic sand. The three sections measured include most of the Piney Point, and have a distinctly different nature from the underlying Woodstock Member of the Nanjemoy Formation and the overlying Old Church Formation of Ward (1984). These sections are located along the Pamunkey River near Horseshoe (Figure 1). The stratigraphy of the Piney Point Formation is illustrated in Figures 2, 3, and 4.

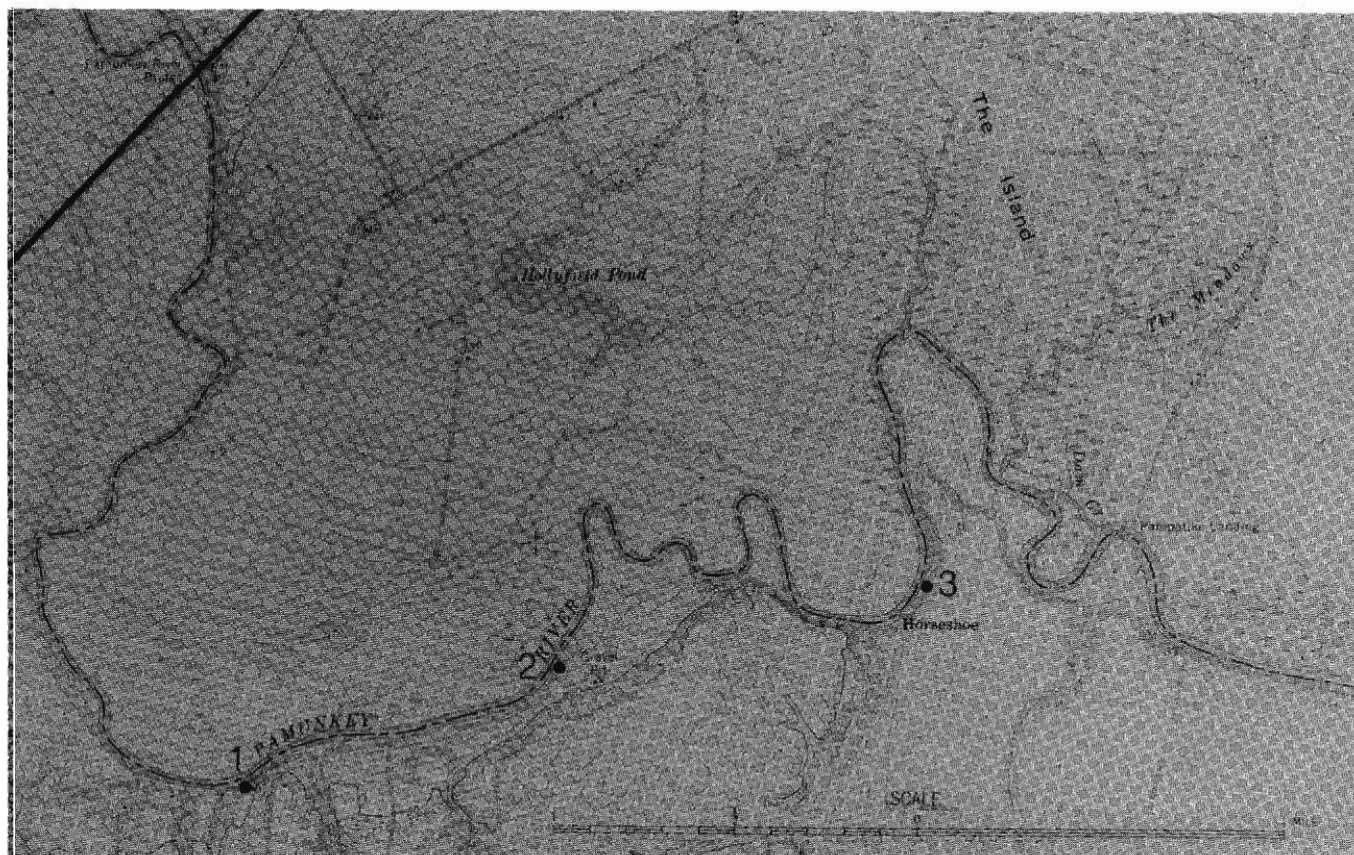


Figure 1. Portion of the Manquin 7.5-minute quadrangle showing the location of the measured sections.

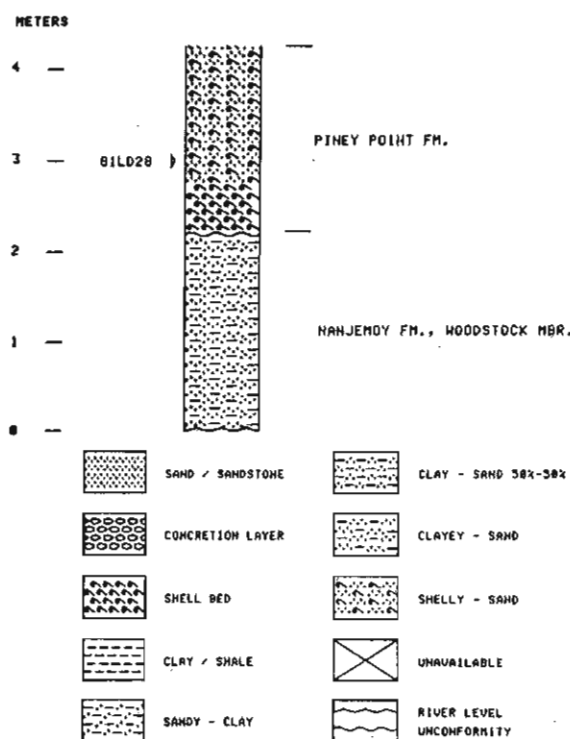


Figure 2. Locality 1, 3.9 miles downstream from the U. S. Highway 360 bridge (Figure 1). Water level through 7.5 feet is the dark green, well sorted clayey sand of the Woodstock Member of the Nanjemoy Formation. An abrupt lithologic change marks the contact between the Nanjemoy and Piney Point formations. A 1.5-foot shell bed overlies this unconformity, grading upward to a light to medium grey-green shelly, sandy unit with little clay, the Piney Point Formation. It contains the middle Claibornian oyster *Cubitostrea selleformis* (Conrad, 1832) and is 5 feet thick.

#### DESCRIPTION OF OSTRACODE FAUNA

Forty-five ostracode species are recognized in the six samples collected from the Piney Point Formation (Deck, 1984, Table 1). Each individually occurring skeletal element, either a valve or a carapace, is counted as one specimen. Nearly all of these species range throughout the Piney Point, with the exception of those represented by less than ten specimens and *Echinocythereis jacksonensis* (Howe and Pyeatt), with a total of 17 specimens, found only in the upper portion of the formation (81LD30, 81LD31, 81LD32). *Cyamocytheridea* n. sp.1 (Deck, 1984), the most abundant species, totaled 307 specimens, while "*Trachyleberis*" *johnsoni*

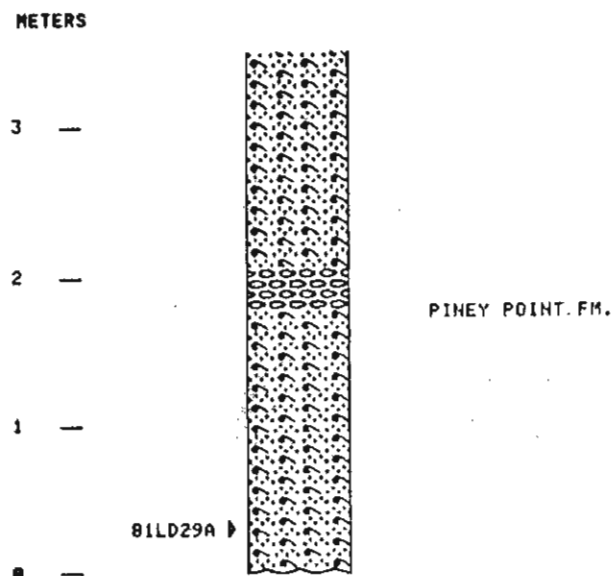


Figure 3. Locality 2, 5.1 miles downstream from the U. S. Highway 360 bridge (Figure 1). This 11.5-foot exposure of Piney Point is light to medium grey-green, shelly, poorly sorted, glauconitic sand. A layer of concretions 1 foot thick occurs in the outcrop 6 feet above water level.

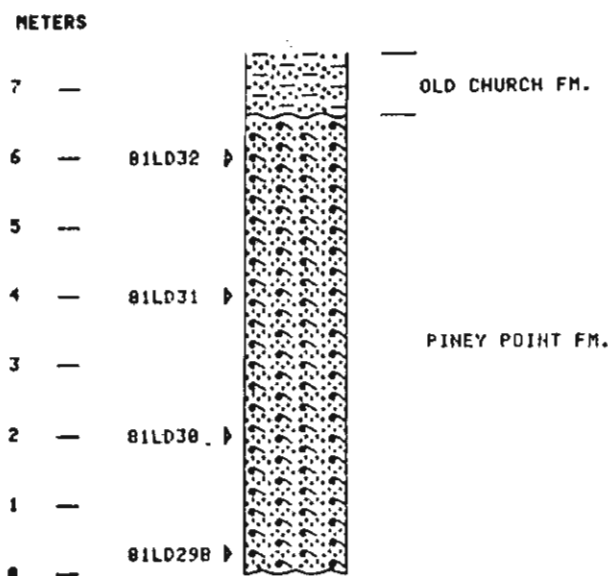


Figure 4. Locality 3, 6.1 miles downstream from the U. S. Highway 360 bridge (Figure 1). The upper 21.5 feet of light to medium gray-green, shelly, poorly sorted, glauconitic sand of the Piney Point Formation is exposed. A lag deposit of shells, pebbles, and bone fragments occurs in the base of the overlying Old Church Formation of Ward (1984). A 3-foot-thick bed of the sandy clay of the Old Church completes the section.



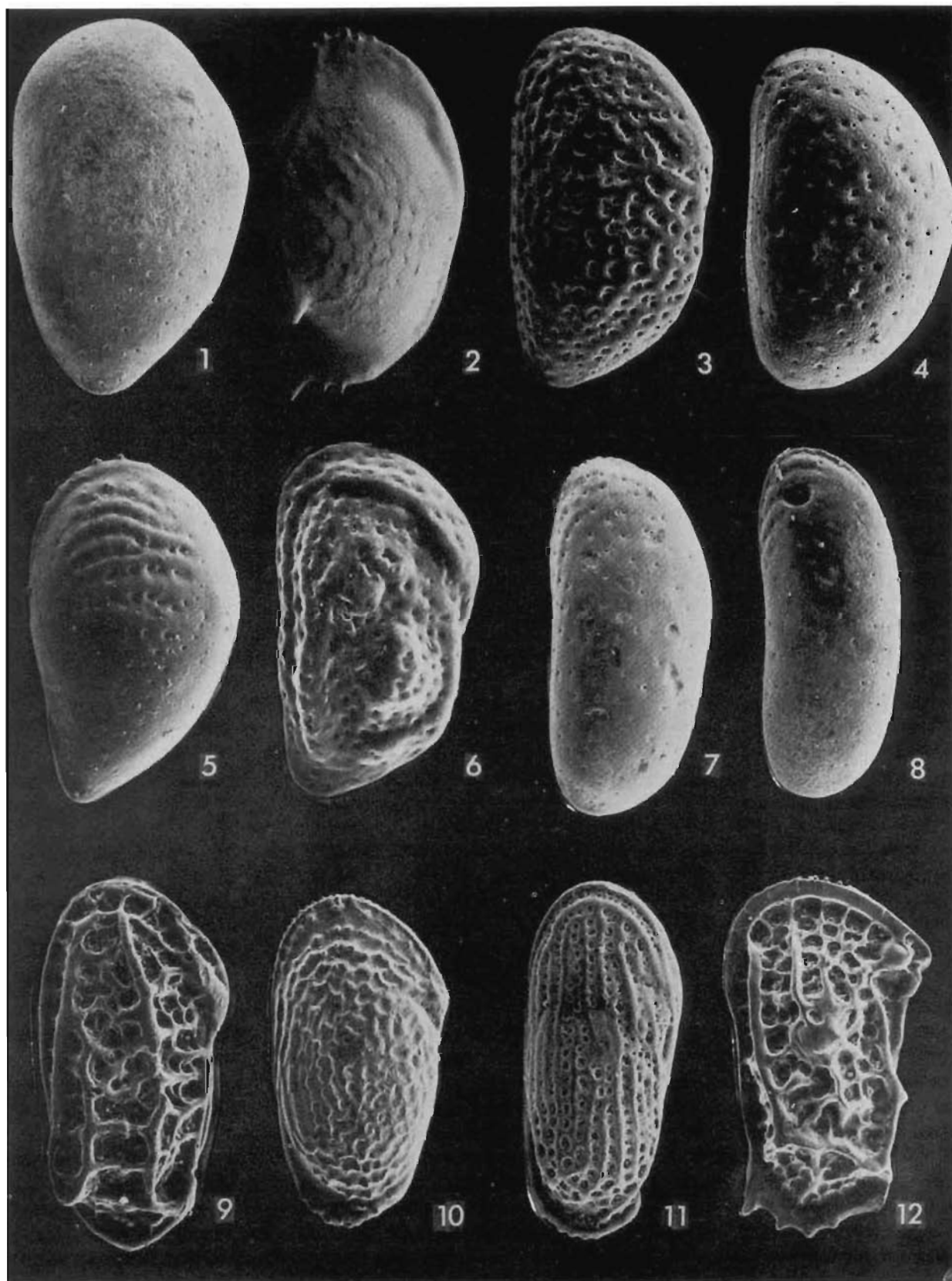


Figure 5. (1) *Bairdoppilata platycoa* (53 x); (2) *Opimocythere martini* (80.5 x); (3) *Clithrocytheridea garretti* (95 x); (4) *Cococia grigsbyi* (77 x); (5) *Haplocytheridea montgomeryensis* (82 x); (6) *Ouachitana caldwelensis* (91 x); (7) *Cushmanidea alta* (82 x); (8) *Cushmanidea gosportensis* (103 x); (9) *"Trachyleberis" johnsoni* (147 x); (10) *Echinocythereis jacksonensis* (66.5 x); (11) *Triginglymus longicostata* (91 x); (12) *Hermanites collei* (110 x). All are female, left valves except *"Trachyleberis" johnsoni*, which is a carapace, left valve view.

Pooser, *Buntoni* aff. *B. alabamensis* (Howe and Pyeatt), and *Loxoconcha* undet. sp. 2 are represented by one specimen apiece. Twelve species recognized in the Piney Point samples have been described previously (Figure 5). The Table contains the ranges of these species. Eleven species have affinities with previously described species and eight additional species are considered distinct enough to be recognized as new species (Deck, 1984). The fourteen remaining species are not represented by enough specimens (at least 20) to be diagnosed because of lack of distinct characteristics.

Over 90 percent of all specimens recovered from the Piney Point are separate valves. Complete carapaces are rare. The valves are well preserved, showing hinge, muscle scar, external ornament, and radial pore canals clearly. Instars (immature shed carapaces) back to A-3 are common. Specimens from samples 81LD28, 81LD29A, 81LD29B, and 81LD30 are very similar in preservation, which is excellent. Specimens in samples 81LD31 and 81LD32 are not as well preserved as the four below them, resulting in pitting in *Cyamoocytheridea* n. sp. 1 and sometimes indistinguishable muscle scars or hinge characteristics.

Table. Range chart of previously described species; E-Early, M-Middle, L-Late.

Species	Sabinian	Claibornian	Jacksonian
	EML	EML	EML
<i>Bairdoppilata platycoia</i>		XX	
<i>Opimocythere martini</i>		XX	
<i>Clithrocytheridea garretti</i>		XXX	XX
<i>Coccolia grigsbyi</i>		X	XX
<i>Haploocytheridea montgomeryensis</i>		XX	XX
<i>Ouachitara caldwelensis</i>		XX	XX
<i>Cushmanidea alta</i>		X	X
<i>Cushmanidea gosportensis</i>		X	X
<i>"Trachyleberis" johnsoni</i>		X	
<i>Echinocythereis jacksonensis</i>		XX	XXX
<i>Triginglymus longicostata</i>		X	X
<i>Hermanites collei</i>	XXX	XXX	XX

## AGE OF THE OSTRACODE FAUNA AND DEPOSITIONAL ENVIRONMENT OF THE PINEY POINT FORMATION

The age of the Piney Point ostracode fauna from the Pamunkey River exposures, determined by correlation with the ostracode faunas of the southern Atlantic Coastal Plain and the Gulf Coastal Plain, is middle Claibornian to middle Jacksonian. The Table is the range chart for the previously described Piney Point ostracodes. The majority of species occurrences and ranges fall within the middle Claibornian (8 occurrences), late Claibornian (11 occurrences), early Jacksonian (9 occurrences) and middle Jacksonian (6 occurrences). The ostracode fauna of the Piney Point Formation is most like the fauna of the Gosport Formation of Alabama, which also is a mixture of middle Claibornian to middle Jacksonian forms (Blake, 1950). The Piney Point Formation appears to be time-transgressive, because early and middle Jacksonian forms are present in the samples obtained from the Coastal Plain portion of Virginia. However, a strictly Claibornian ostracode fauna is found in the water well material identified by Brown, Miller, and Swain (1972) from the type locality in St. Marys County, Maryland.

The relatively high number of ostracode species (forty-five) found in the Piney Point and the moderate to high number of individuals suggest that it was deposited under normal marine conditions. The affinities of this ostracode fauna to those from the Gulf Coastal Plain support this idea as well. Environmentally, the two areas were quite similar, having a predominantly clastic sediment regime and warm temperatures, based on the molluscan fauna (Ward, 1984).

Slow sedimentation is indicated by the presence of glauconite throughout the Piney Point Formation (Owens and Sohl, 1973). It is further evidenced by the excellent preservation of the ostracodes. Most ostracode specimens were recovered as valves, not complete carapaces, and in a fossil assemblage the predominance of valves over carapaces has been correlated with slow sedimentation rates (Pokorny, 1965; Oerti, 1972). The preservation of the individual valves is excellent, indicating little transport, and probably quiet conditions as exist below wave-base. *Asterigerina texana*, the associated foraminifera, prefers clear, warm waters (Paul Huddleston, 1984 oral communication), which also supports slow sedimentation with little transport or abrasion.

The ecology of the ostracode genera in the Piney Point suggests that deposition occurred in a shallow shelf, warm, open marine system. Some of the genera, such as *Haplocytheridea* and *Clithrocytheridea* and related genera, are recognized as indicative of an intralittoral or marginal marine environment. However, all identified genera are common in open marine waters as well (Van Morkhoven, 1962).

#### ACKNOWLEDGEMENTS

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#### NEW PUBLICATIONS

##### PUBLICATION 43

**Relationship of Stratigraphy to Occurrences of Oil and Gas in Western Virginia, by D. C. LeVan and E. K. Rader; one sheet, 1983.**

**\$6.00**

In this publication, the western portion of the State is divided into six areas, each having a representative stratigraphic column and brief summary of oil and gas production. Oil and gas occurrences are denoted by symbols representing major sources to small amounts or shows. These symbols have been placed in their relative stratigraphic position next to the corresponding formation or member. Published reports from which some of the data was collected are listed in references. The legend and map have been color-coded to aid in distinguishing dominant lithology.

This publication (one sheet) can be ordered from the Division for \$6.00. A four percent sales tax will be added to in-State orders; postage will be billed.

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#### PUBLICATION 44

**Selected Karst Features of the Northern Valley and Ridge Province, Virginia, by David A. Hubbard, Jr.; one sheet, 1983.**

**\$4.00**

This publication provides a guide to potentially hazardous karst areas. Sink holes and cave entrances are shown throughout the northern Valley and Ridge Province (scale 1:250,000). The map also shows contact lines, faults, and major drainage divides. Lithologic units are designated on the map by numbers and are listed in the explanation. The text includes karst development and potential karst hazards. Separate lists of references are given for the text and map.

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#### PUBLICATION 45

**Virginia Gold-Resource Data, by Palmer C. Sweet and David Trimble; 196 p., 1983.**

**\$10.00**

Information on 226 gold mines and prospects is listed in Virginia Gold-Resource Data. The mines and prospects are arranged alphabetically by county with 25 county location maps on which most of the mines and prospects are plotted. Their position from the nearest prominent locality is given as well as a field description presented under "Location Comments". Furthermore, their positions can be determined on a geologic quadrangle map from the given latitude and longitude coordinates.

In this computerized listing, a description of the deposit, exploration and development, and geology and mineralogy are given. Other pertinent information such as description of workings (surface and underground) and present owner is also included. General references are cited for each mine or prospect.

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#### PUBLICATION 46

**Coal-Bed Methane Resource Evaluation, Montgomery County, Virginia by C. B. Stanley, A. P. Shultz, and others; 59 p., 1983.**

**\$5.00**

In this investigation, the Mississippian age coal beds near Blacksburg, Virginia (the Valley coal fields of southwestern Virginia) were evaluated for potential commercial quantities of methane. The area was tested by drilling three diamond core holes: the Sunnyside, Merrimac, and Prices Fork test wells. The gas content of Price Formation coals was determined and an analysis made for the Sunnyside and Merrimac test wells (the Prices Fork test well had to be abandoned). Stratigraphy and structure have been described for general geology as well as the Price and Maccrady formations. Lithologic and geophysical well logs for the two test wells are presented. A detailed lithologic description of core for these wells concludes the report. The economic feasibility was examined by projecting well productivity and predicting financial outcome.

This publication can be purchased at the Division for \$5.00. Sales tax (four percent) will be added to publications purchased by Virginia residents; postage will be billed.